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Local thermoelectric probes of nonequilibrium quantum systems[1]

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A theory of local temperature and voltage measurement in an interacting quantum system far from equilibrium is developed. We prove that a steady-state measurement by a floating thermoelectric probe is unique if it exists. Furthermore, we show that a solution exists provided there is no net local population inversion. In the case of population inversion, the system may be assigned a (unique) negative temperature. An expression for the local entropy of a nonequilibrium quantum system is introduced that, together with the local temperature and voltage, allows for a complete analysis of the local thermodynamics of the thermoelectric processes in the system. The Clausius form of the second law and the third law are shown to hold exactly locally, while the zeroth and first laws are shown to be valid to leading order in the Sommerfeld expansion. The local quantum thermodynamics underlying the enhancement of thermoelectricity by quantum interference is discussed.

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